NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

IRRIGATION SYSTEM, SPRINKLER

(No. and Acre)
CODE 442

DEFINITION

A planned irrigation system in which all necessary facilities are installed for efficiently applying water by means of perforated pipes or nozzles operated under pressure.

PURPOSE

To efficiently and uniformly apply water to maintain adequate soil moisture for optimum plant growth without causing erosion or reduced water quality.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to sprinkler irrigation systems through which water is distributed by means of sprinklers, spray nozzles, drag socks, or bubblers. It applies to all components of the on-farm system except for special structures such as permanently installed mains and laterals, Irrigation Water Conveyance, Pipeline, 430, and pumps, Pumping Plant for Water Control, 533. It does not include Micro Irrigation Systems (441).

Sprinkler irrigation plans shall be based on an evaluation of the site and the expected operating conditions. The soils and topography shall be suitable for irrigation for the proposed crops.

Sufficient water, of quality appropriate for the crop(s) to be grown, must be available to make irrigation practical.

The sprinkler method of water application is suited to most crops, to most land to be irrigated, and to most climatic conditions.

Low Energy Precision Application (LEPA) is a sprinkler irrigation system that either bubbles water directly onto the ground or that applies water by dragging a sock or tube on the ground at a maximum 60" spacing or every other furrow, whichever is greater, wetting only part of the field surface. These systems are commonly center pivot or linear move.

LEPA applies to irrigated land where surface redistribution of applied water is not readily apparent on permanently vegetated fields or cropped fields with slopes of up to 2% on a majority of the field. Slopes of 3% may be allowed on portions of the field if, in the opinion of the NRCS Conservationist / Technician and based on soil type, texture, and infiltration rate, redistribution of surface water will not materially affect irrigation efficiency or cause soil erosion.

LEPA does not apply to in canopy or over canopy, low pressure spray systems.

Low Elevation Spray Application (LESA) is a sprinkler irrigation system that uses spray applicators to deliver water near the top of the crop canopy in a manner in which water from each nozzle usually overlaps at least 50% with adjacent nozzles.

LESA typically uses lower frequency of application (5 to 7 days) than LEPA with more water applied per cycle. LESA loses efficiency mainly from wetting more soil surface area but is inherently more efficient than impact sprinklers that deliver water from a higher point above the crop canopy.

CRITERIA, ALL SYSTEMS

Capacity. In regularly irrigated areas, sprinkler irrigation systems shall have either:

- A design capacity adequate to meet the moisture demands of all crops to be irrigated in the design area, or

- Enough capacity to meet the requirements of several selected irrigations during critical crop growth periods when less than full irrigation is planned.

Depth of application. The gross depth of water application shall be based on the available moisture capacity of the soil in the root zone of the crop irrigated or a lesser amount consistent with the land user's operation plan and field application efficiencies consistent with the conservation of water.

For LEPA, the gross depth of water application shall be further limited to the soil moisture deficit without visible surface water movement.

Design application rate. The design rate of application shall be within a range established by the minimum practical application rate under local climatic conditions and the maximum rate consistent with the intake rate of the soil. If two or more sets of conditions are in the design area, the lowest maximum application rate for areas of significant size shall apply.

Distribution patterns and spacing. A combination of sprinkler spacing, nozzle sizes, and operating pressure that most nearly provides the design application rate and distribution shall be selected. The velocity of prevailing winds and other conditions must be considered.

If available, uniformity coefficient data shall be used in selecting sprinkler spacing, nozzle sizes, and operating pressure. The uniformity coefficient shall be not less than as shown below:

- 70% for orchards,
- 75% for deep-rooted crops,
- 85% for high-value or shallow-rooted crops and for any crop where fertilizer or pesticides are applied through the system.

In the absence of such data, the sprinkler performance table provided by the manufacturer shall be used in selecting nozzle sizes, operating pressure, and wetted diameter for the designed sprinkler discharge.

The maximum spacing shall comply with the following criteria:

- For low to moderate pressure sprinklers, the spacing along lateral lines (S_l) shall not exceed 50 percent of the published wetted diameter when the sprinkler is operating under design pressure. The spacing of laterals along the main line (S_m) shall not exceed 65 percent of this wetted diameter. If winds that can affect the distribution pattern are likely, spacing (S_m) shall be reduced to 60 percent for average velocities of 5 mi/h, to 50 percent for average velocities of 10 mi/h, and to 30 percent for average velocities greater than 10 mi/h.
- For high-pressure sprinklers and for the giant hydraulic type, the maximum distance (diagonal) between two sprinklers on adjacent lateral lines shall not exceed two-thirds of the wetted diameter under favorable operating conditions. If winds that can affect the distribution pattern are likely, the diagonal spacing shall be reduced to 50 percent of the wetted diameter for average velocities of 5 mi/h and to 30 percent for average velocities greater than 10 mi/h.
- For perforated pipelines, the spacing recommendations of the manufacture for the design application rate, number and size of perforations, and operating pressure shall be followed.

Lateral lines. Lateral lines shall be so designed that the total pressure variation at the sprinkler heads, resulting from friction head and static head, does not exceed 20 percent of the design operating pressure of the sprinklers.

Except for under-tree operation, risers installed on lateral lines shall be long enough to prevent interference with the distribution pattern for the tallest crop. Riser length shall not be less than shown in **Table 1.**

Table 1

Sprinkler discharge (gpm)	Riser length above crop (inches)
Lessthan10	**6**
10-25	**9**
25-50	**12**
50-120	**18**
More than 120	**36**

Main lines. The design of main lines, submains, and supply lines shall insure that the quantities of water required are conveyed to all lateral lines at the required pressure.

Pipelines shall be sized to ensure that there is an economical balance between the capitalized cost of the pipe and annual pumping costs. While oversizing of the mainline is initially more expensive, the reduction in friction loss might reduce energy cost, pump size, and also overall operating cost on a long-term basis.

Pump and power unit. The pump capacity and the power unit shall be adequate to operate the sprinkler system efficiently when operating at design capacity against the designed total dynamic head.

Operating pressure shall be based on supplying the device outlet pressure at the most critical system position. This includes any regulator loss, pipe friction loss, and elevation difference.

The efficiency of the pumping plant must be determined at design capacity and pressure..

New pumping plants shall have a pump efficiency rating of 80% or greater, at the design discharge and pressure.

ADDITIONAL CRITERIA, LEPA

Cultural tillage and/or residue management shall be utilized as necessary to prevent surface redistribution of applied water.

Refer to the National Engineering Handbook, (NEH), Part 652, Page 6-50, for guidance on soil surface storage design.

For LEPA center pivot circular and linear plantings, water shall be discharged in the center of each or every other row.

Water applications shall be discharged on or near the soil surface by:

- Drag socks: discharge height shall be on the soil surface or,
- Bubbler mode: discharge height shall be 8 to 18 inches above the soil surface.

Application devices shall be at uniform heights above the soil surface throughout the field.

The length of drop tubes shall allow the application device to discharge flows at the desired heights, considering loaded span deflection and allowance for the tire track depression.

Initial device coefficient of uniformity (CU) shall be 96% of the mean or greater, as determined using National Engineering Handbook (NEH), Section 15, Chapter 11. It shall not be less than 94% of the mean when considering operational wear of nozzles and equipment.

All drop tubes may need to be uniformly equipped with pressure regulators set at 10 psi (69 kPa) or less in order to achieve the required CU.

The application devices shall not apply water in a tower wheel track.

CONSIDERATIONS

Consider uniformly equipping all drop tubes in LEPA systems with pressure regulators set at 10 psi (69 kPa) or less in order to improve the CU above the required.

A retrofit system's pumping plant should be modified as necessary to supply the new pressure and flow requirements at pump efficiency of not less than 65%.

Potential ability to manage irrigation water through control of water in the root zone.

Effects on erosion and the movement of sediment, and soluble and sediment-attached substances carried by runoff.

Effects of nutrients and pesticides on surface and ground water quality.

Potential effects on the movement of dissolved substances below the root zone or to ground water.

Effects of soil water levels on such nutrient processes as nitrification and de-nitrification.

Effects of soil water levels in controlling the salinity of soils, soil water, or downstream water quality.

Effects on the visual quality of downstream water resources.

By maximizing effective precipitation, irrigation water requirement may be reduced. Successfully adopting and implementing a LEPA irrigation system requires a commitment by the owner/operator to apply good soil and water management.

Reduced tillage operations utilized to help prevent surface redistribution should be considered in all sprinkler systems.

Soil surface storage basins, furrow dikes, or reservoirs may also be necessary to reduce surface water movement.

The effects of practices such as, surface roughening, in-furrow chiseling, furrow dikes, reservoirs, and / or surface residue management usually diminish over the irrigation season.

Crop rows should be oriented with the direction of movement of the application device. This reduces the maximum discharge to single furrows and the likelihood of the wheel track intercepting furrow water.

Consider crop row spacing, width of available framing equipment, and distance between tower spans when determining tube spacing.

Drop tubes should be installed alternately on both sides of the mainline and have a flexible joint between the gooseneck pipes and the application device. Drops may need to be secured and/or weighted in windy areas.

When crop rotations and/or variable crop spacing are called for, flexible devices and fittings that allow for height variation and tube location should be used.

Water should be applied to furrows not compacted by farming equipment when alternate furrows are irrigated.

It is common practice to provide the first span or two on center pivot systems with low operating pressure application devices (spinners, spray nozzles, etc. not restricted to 10 psi) attached to drop tubes.

Fertilizer amounts may need to be adjusted from prior fertigation methods and rates due to precise applications of water and plant nutrients in the amount and timing to meet crop needs.

Management of the LEPA system for deficit irrigation should include utilizing the soil water stored in the root zone during the most critical crop growth stages.

The speed of the system should generally be increased to decrease surface water redistribution if it occurs. When the speed is increased, the irrigation cycle will need to be more frequent to meet planned crop needs. On low intake and cracking soils, it might be desirable to provide a less frequent cycle. This would allow for soil cracking between applications and take advantage of the higher intake rates until the cracks seal. This may allow for increased application volumes.

Effects on the water budget, especially the volume and rate of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.

Potential for changes in plant growth and transpiration because of changes in the volume of soil water.

The effect on the water table of the field in providing suitable rooting depth for anticipated land uses.

PLANS AND SPECIFICATIONS

Site specific plans and specifications for sprinkler irrigation systems shall be in keeping with this standard and shall describe the requirements for properly installing the practice to achieve its intended purpose.

Plans and Specifications include engineering drawings, specifications, nozzle layout, pump performance data, and / or job sheets.

OPERATION AND MAINTENANCE

An operation and maintenance plan must be provided to the system operator. The plan should provide specific instructions for operating and maintaining the system to insure that it functions properly. It should also provide for periodic inspections and prompt repair or replacement of damaged components.

The system shall be maintained and managed so as to apply the designed volume of water in a timely and controlled manner.

System components will need to be adjusted or replaced if the CU drops below acceptable levels.

Designed soil surface and/or residue storage capacities shall be maintained or reinstalled throughout the irrigation season to limit surface redistribution from irrigation.

SAFETY

When chemigation is incorporated into a sprinkler system, a back flow prevention assemblage, similar to American Society of Agricultural Engineering (ASAE) standard EP409, is required to prevent back flow and water source contamination. The prevention assembly shall be installed between the water source and point of chemical injection. Refer to Conservation Practice 430DD, Irrigation Water Conveyance, High Pressure, Underground, Plastic Pipeline, for details

Prior to retrofitting any electrically powered irrigation equipment, electrical service must be disconnected and appropriately verified that there is no stray electrical current.

REFERENCES

National Engineering Handbook, Part 652, National Handbook of Conservation Practices, Section IV